DOCUMENT RESUME

ED 393 288 EC 304 739

AUTHOR Kim, Dong-Il
TITLE An Exploratory Study on Academic Skill-Oriented Subtypes of Students at Risk: A Validation of the BASS.
PUB DATE 3 Apr 96
NOTE 33p.; Paper presented at the Annual International Convention of the Council for Exceptional Children (74th, Orlando, FL, April 1-5, 1996).
PUB TYPE Speeches/Conference Papers (150) -- Reports - Research/Technical (143)

EDRS PRICE MF01 Plus Postage. PC Not Available from EDRS.
DESCRIPTORS Academic Achievement; Age Differences; *Classification; Cluster Analysis; Diagnostic Tests; Early Identification; Elementary Education; High Risk Students; *Language Skills; *Learning Disabilities; Literacy; *Screening Tests; Severity (of Disability); *Student Characteristics; *Test Validity
IDENTIFIERS *Basic Academic Skills Samples; Minnesota; Subgroups

ABSTRACT

Hierarchical cluster analysis techniques were used to identify subtypes of 125 Minnesota students with learning disabilities (LD) in grades 1 through 6, and to investigate their academic performance. The measure used for clustering was the Basic Academic Skills Samples (BASS), an index of student proficiency in basic academic skill areas (reading, spelling, and written expression) developed as a screening measure for early identification of students in need of additional help. There were two distinct patterns across grade levels. The first pattern was characterized by general deficiency across areas; the second by specific skill deficiencies. The patterns were also differentiated in terms of the degree of the deficiency. The LD sample showed general deficiencies across the three language-related academic skill areas at each grade level, compared to the grade norm. More differentiated subtypes existed among older students. The study found that the BASS measures could be used to identify students with learning problems and the subtypes of those problems in terms of specific skill deficiencies. (Contains 24 references.) (DB)

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ED 393 288

AN EXPLORATORY STUDY ON ACADEMIC SKILL-ORIENTED SUBTYPES OF STUDENTS AT RISK: A VALIDATION OF THE BASS

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DONG-IL KIM

KOREA COUNSELING INSTITUTE

Paper presented at the Annual Convention of the Council for Exceptional Children, April 1-6, 1996, in Orlando, Florida.

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RUNNING HEAD: ACADEMIC SKILL-ORIENTED SUBTYPES

Abstract

Hierarchical cluster analysis techniques were used to identify subtypes of students with learning disabilities in grades one through six, and to investigate their academic performance. The measure used for clustering was the Basic Academic Skills Sample(BASS), an index of student proficiency in basic academic skill areas. There were two distinct patterns across grade levels; the first characterized by general deficiency across areas, the second by specific skill deficiencies. The patterns were also differentiated in terms of the degree of deficiency. The potential utility of the BASS for screening and subtyping of students at risk was explored and discussed.

Introduction

Historically, the term "learning disabilities" has been used to describe the problems manifested by a group of children who have difficulties in one or more the basic school subjects and are eligible for special education services by the exclusion of other types of handicaps. These "underachieving" students should be identified early in their school career so that teachers can provide adequate interventions before their failure becomes permanent. Early identification requires that teachers be able to screen students and accurately pinpoint those in need of help.

Commercial standardized achievement tests have several shortcomings when used as screening instruments, including long test-taking time, difficulty in administration and interpretation, little information for implementation of prereferral interventions, and so on. In recognition of these problems, an alternative performance assessment procedure was devised (Espin, Deno, Maruyama, & Cohen, 1989) - the Basic Academic Skills Samples (BASS), a screening instruments that produce indices of student achievement in the basic academic skill areas. The BASS emerged from research on Curriculum-Based Measurement procedures (Deno, 1985) designed to monitor student growth in academic areas. Research on these procedures has shown their validity and reliability in measuring student growth in academic skills, and their utility for instructional decision making (Marston, 1989). A series of validation studies supported the criterion-related validity of the BASS (Espin, Deno, Maruyama, & Cohen, 1989). Additionally, in order to show the instrument's usefulness for identifying students with learning difficulties in regular education classrooms, a discriminant analysis was conducted. The BASS accurately classified between 75% and 93% of students receiving special education services (Learning Disabilities).

Although the overall measures of the BASS seem to be reliable and adequately discriminate students with learning disabilities from regular education students, more detailed examination of the characteristics of students with learning disabilities is in order, because finding subgroups with identifiable characteristics (particular strengths and weaknesses) is required for developing appropriate interventions. The present study examined the utility of the BASS for identifying meaningful subtypes of students with learning disabilities across different academic areas (reading, spelling, and written expression). This investigation is, therefore, a follow-up validation study of the BASS.

Subtyping of Students with Learning Disabilities

Since all known forms of exceptionality have been excluded from the current definition of learning disabilities, researchers in the field have tried to identify underlying handicapping conditions over the past two decades. From the various deficits displayed by students with learning disabilities, McKinney (1984) claimed that "it has become increasingly clear that a single syndrome theory cannot account for the substantial heterogeneity within samples" (p. 43). This heterogeneity of students with learning disabilities comes not only from the present theoretical controversy (conceptual definitions) but also from identification in practice (operational definitions). The research based on "system-identified" students with learning disabilities, therefore, has limited generalization, especially due to the problems of heterogeneity. School districts categorize students in order to provide services, not to ensure homogeneity of characteristics for research purposes (Keogh, 1987). School districts also differ in a number of ways that may cause variations in the numbers and types of students selected, such as their staffing and resources.

Subtyping research, as it is currently practiced, strives to divide heterogeneous samples of students with learning disabilities into homogeneous subgroups based on their patterns of performance across a variety of tests or other measurements (Forness, 1990). In such studies, various methods have been used to classify students with learning disabilities. Most of the work on learning disability subtypes have been confirmed to the study of reading disabilities (McKinney, 1984).

Research on subtypes of students with reading disabilities can be categorized into two approaches (Satz & Morris, 1981). The majority of early studies on subtypes used an inferential approach that involved the sorting of children into clinical syndromes based on various a priori theoretical considerations, such as subtest scatter in IQ test scores or neuropsychological classification (Feagans & McKinney, 1991). These approaches, however, suffered from a number of limitations, including inconsistent findings, biased clinical samples, and inadequate visual inspections (McKinney, 1984).

The second approach is empirical calssification using Q-factor analysis (Doehring & Hoshko, 1977; Doehring & Bryans, 1979; Fisk & Rouke, 1979) or hierarchical cluster techniques (Lyon & Watson, 1981; Satz & Morris, 1981). The Q-factor analysis has been criticized on several grounds (Morris, Blashfield, & Satz, 1981), including the implausible use of a linear model across subjects, the issue of multiple factor loadings, and the inappropriate use of a correlation coefficient as a measure of similarity between subjects (Everitt, 1980). Furthermore, the maximum number of subtypes that can be identified cannot be more than the rank of the matrix of Q correlations. Another shortcoming is that the Q-factor technique identifies groups according only to pattern similarity, whereas the elevation and distance dimensions of the measures are often emphasized in learning disability research and practice.

Cluster analysis is an iterative multivariate technique which successively

matches students according to either their pattern of responses or their level of responses across an array of variables (Everitt, 1980). Although the use of cluster analysis may represent an approach to classifying subjects that satisfies many of the criticisms of Q-factor analysis, many learning disability subtyping studies using this technique also has several limitations.

First, many cluster analytic studies have not had clear hypotheses about the number and characteristics of the clusters to be found. In the absence of theory or prior knowledge regarding the kinds of subgroups likely to be present in a population, use of cluster analysis amounts to "an empirical fishing expedition" (Feagans & McKinney, 1991, p.24). Relevant theoretical understanding about the target behavior, therefore, is necessary to proceed with research on subtyping.

Second, the psychological and neuropsychological processing tests or related procedures typically used to determine underlying disorders are notoriously unreliable (Forness, 1990). Third, many studies have had serious methodological and statistical limitations or have failed to account for significant amounts of variance within their samples. Kavale and Forness (1987) showed that a subtype with no particular pattern of underlying deficit made up nearly 30% of the samples, on average, over 15 studies.

Fourth, measures in most studies were based on norm-referenced achievement tests or intelligence tests, which do not directly assess the student behaviors that elicited the refferals. These studies also assessed psychological process, hypothetical constructs, or intervening variables, but seldom involved direct observation and measurement academic behavior in the classroom (Lentz, 1988). Unfortunately, recent conclusions drawn from the empirical literature have failed to support either the utility of process measures in planning for remediation of basic skills, or the utility of underlying constructs as targets in the remedial process (Kavale & Forness, 1985). Similarly, the adequate of traditional measures for the classification of

students with learning disabilities have often been questioned (Lentz, 1988). Even less process-oriented measures, such as norm-referenced achievement tests, have not proven very useful for planning reading instruction (Deno, 1985). For these reasons, it would seem preferable to use direct measures of academic behaviors in cluster analytic studies; this may help to ensure that institutionally meaningful subgroups will be identified.

Finally, a developmental perspective on the classification of students with reading disabilities is needed, since most previous studies utilized subjects within a relatively restricted age or grade range (McKinney, 1984). Stability and change in reading achievement have been major topics in the history of education. It is necessary to understand how different subtypes of reading disabilities emerge, and the developmental paths they follow.

This exploratory investigation attempted to identify subtypes of students at risk, and to examine their performance at each grade level. It was expected that cluster analysis of direct performance measures of academic skills would yield some identifiable subtypes. Stability and differentiation of the subtypes of learning disabilities were also examined across grade levels. Information regarding the developmental aspects of students with learning disabilities is scarce, so a cross-sectional design seemed to be a meaningful first step.

Method

Subject/Setting

The subjects were 125 school-identified students with learning disabilities in grades one through six. They were from a larger sample participating in a federally funded project concerning at-risk students (Espin, Deno, Maruyama, & Cohen, 1989). The sampling procedure was as follows:

Thirty-one elementary schools in the state of Minnesota expressed an interest in being part of the study. Class lists were obtained from these schools for grades one through six, and six students, three boys and three girls, were randomly selected from each class. After the random selection process was completed, the building level coordinators identified the special education students within the sample who had an Individual Education Plan (IEP), and indicated each student's primary handicapping condition.

The total number of students and the number of students with learning disabilities by grade can be seen in Table 1. Overall, approximately 8% of the random sample were identified as special education students. Five different categories of special education students were represented: Learning Disabilities (LD), Speech and Language (SL), Emotional/Behavioral Disorders (EBD), Mildly Mentally Handicapped (MMH) and Hearing Impaired (HI). The subgroup of LD students made up around 5% of the sample. For the LD classification, students met eligibility criteria of the state of Minnesota and their own school district.

Insert Table 1 about here

Measures

Student academic performance was measured using the BASS (Espin, Deno, Maruyama, & Cohen, 1989). The primary reason for developing the BASS was to obtain an index of proficiency in reading, spelling, written expression, and arithmetic across a large sample in a short time period. In the present study, reading, spelling, and written expression subtests were used for classification.

The BASS includes two written expression probes, two spelling probes, and three reading probes. Students are given one to two minutes to complete each probe. The entire instrument can be completed in approximately 20 to 30 minutes.

Reading Subtest. The BASS differs from CBM techniques (Deno, 1985) in the area of reading. CBM techniques typically utilize oral samples for a measure of reading competence, but oral reading samples cannot be administered to a group in an efficient manner. For this reason the measure chosen to assess reading competency in the BASS was the Maze technique, a modified Cloze procedure (Ekwall, 1976). In this technique every seventh word is deleted and replaced by a multiple choice array of three items. Students are asked to select the correct word.

The reading passage used for all students are first grade passage of at least 200 words. Performance on the reading subtest is scored by counting the number of correct multiple choices (CMC) and subtracting the Incorrect Multiple Choices (IMC) to control for guessing. This score is labeled Correct/Incorrect (CI). Scoring choices as correct was terminated after students made three consecutive incorrect choices to prevent students from adding to their score by guessing.

Written Expression Subset. For written expression the students are presented with a "Story Starter." They are given thirty seconds to think about what they will write and two minutes to write the story. Written expression is scored by counting the total number of words written and spelled correctly (WC). The context of the words is not considered. If the words is a correctly spelled English word it is marked as correct.

Spelling Subtest. Spelling words were randomly selected from the

Harris-Jacobson Word List (1972), Pre-primer to Grade 3. Words are dictated to students via audio-tape to control for differences in pronunciation and timing. Students are given seven seconds to write each word. Words are dictated twice within seven seconds. Homonyms are given in the context of a sentence, as well as dictated alone. Spelling words are scored according to the number of correct letter sequences (CLS) (White & Haring, 1980).

Procedures

The BASS was administered to 2,593 students in grades one through six in the 31 participating elementary schools over a 3-week period. The BASS was administered by trained graduate students to groups of approximately 20-50 students.

Results

Tables 2 and 3 display means and standard deviations for the whole sample and the LD group. The raw scores for the academic skill measures in the LD group were converted to z-score within each grade for comparison of relative standings in the areas of reading, spelling and written expression.

Insert Tables 2 and 3 about here

A hierarchical agglomerative cluster technique was used to identify the subgroups (Everitt, 1980; Morris, Blashfield, & Satz, 1981). Three decisions

must be made in using this technique. The first step is to select an appropriate association measure. In this study, the elevation rather than pattern similarity across academic areas is an important consideration, so the squared Euclidean distance measure was used. Two children may have the exact same pattern of performance (i.e., r=1.00), but if one performs at a superior level, while the other is at a deficit, they are different in a very important way.

The second decision to be made when using cluster analysis is which method to use for defining the similarity (or dissimilarity) between and within groups of subjects. The group average linkage method was employed in this study because several Monte Carlo studies showed that this algorithm is superior for recovery of correct cluster structure (Lorr, 1983; Milligan, 1981).

The third decision concerns the number of clusters. There are several criteria to consider, such as the researcher's hypothesis or interpretability of the data. One heuristic method is to find breaks in the curve of dissimilarity coefficients plotted against the number of clusters. In this study, looking for breaks in the curve leads to 2-cluster (Grade 1), 2-cluster (Grade 2), 5-cluster (Grade 3), 6-cluster (Grade 4), 3-cluster (Grade 5), and 6-cluster (Grade 6) solution.

Among these solutions, however, there were some problems in Grades 3 and 4. Some clusters from these grade contained only one student, and did not become incorporated into any of the larger clusters until the end of clustering process. Following the recommendation of Everitt (1980), these students were considered "outliers" and were dropped from further consideration. Outliers may be viewed as resulting from measurement error, or as being unique individuals for whom there are few comparable individuals in a given sample. When using elevation measures, all hierarchical procedures are highly sensitive to outliers, and, therefore, often fail to get appropriate recovery of the cluster structure (Lorr, 1983). For that reason, it

is often necessary to remove outliers prior to the final solution.

For an illustration of the outlier problem, profiles of two one-student-clusters from the Grade 3 sample are provided (Figure 1). In order to facilitate interpretation, the cluster profile points (average z-scores) for the LD sample (n=28) were plotted relative to the BASS standard scores. This method of graphing provides an anchor point from which to view the relative strengths and weaknesses of the clusters. A z-score below -1 (15th percentile) indicates a "deficiency" in a particular skill area. In Figure 1, these two outliers showed sizable discrepancies across academic areas. Two outliers hardly had any severe deficiencies in basic skill areas whereas all the mean profiles of the LD sample were below -1. A major consensus of the LD definition is "underachievement" (Hammill, 1990). This discrepancy over "deficiency" level can be obtained from the profiles of regular education students.

Insert Figure 1 about here

After removing the "outliers", the number of clusters in each grade level was identified (Grade 1, n=2; Grade 2, n=2; Grade 3, n=2, Grade 4, n=3; Grade 5, n=3; Grade 6, n=4). As a validation of the number of clusters in each grade level, three different algorithms (Ward's minimum variance method, centroid clustering, complete linkage) were applied to check whether the same clusters solutions emerged. Comparing solutions across different algorithms as a way of internal validation is based on the notion that a cluster structure should not be algorithm-dependent (Lorr, 1983). Every approach produced identical memberships for all students in each grade level, indicating that the cluster structures were highly stable.

Figure 2 illustrates the average z-scores of the LD sample and two clusters in Grade 1. The LD sample in grade 1 showed general deficiencies

in written expression and spelling. The first cluster contained 7 out of 13 of the LD sample. The second cluster included 6 students and showed relatively low profiles without any severe deficiencies. In both clusters, reading did not contribute to identification of the clusters. This was due to a floor effect on the reading measure in the BASS, which was too difficult for the first graders, in general. These two clusters were significantly differentiated by a Multivariate Analysis of Variance (MANOVA), $F(3, 9)=19.58$, $p<.001$, with two univariate tests being significant: Written expression, $F(1, 11)=13.42$, $p<.01$; spelling, $F(1, 11)=37.01$, $p<.001$.

Insert Figure 2 about here

The LD sample in Grade 2 showed an overall deficiency (Figure 3). Approximately 70% of the sample was classified in the first cluster, which appeared to represent a general deficiency across areas, particularly in spelling. The second cluster was characterized by a specific deficiency only in reading. A MANOVA was also conducted to show that these two clusters were different from each other ($F(3, 20)=17.59$, $p<.001$). The following three univariate tests (reading, written expression, and spelling) were also significant ($p<.05$).

Insert Figure 3 about here

The third grade LD sample also showed an overall deficiency like the second grade sample (Figure 4). About 68% of the sample belonged to the first cluster, which represented the same pattern of deficiency as the third grade LD sample, but with slightly lower scores. Cluster 2 was distinguished

from the Cluster 1 by higher scores in all areas. However, reading is the common problem for both clusters. These clusters turned out to be different from each other, as shown by MANOVA ($F(3, 21)=25,47$, $p<.001$), with two univariate follow-up tests being significant (written expression, $F(1, 23)=8.42$, $p<.01$; spelling, $F(1, 23)=60.11$, $p<.001$).

Insert Figure 4 about here

In Figure 5, the fourth grade LD sample was similar to the second and third grade samples, showing overall deficiencies. Three clusters were produced at Grade 3. 13 out of 24 students were identified in the first cluster, which reflected a general deficiency and similar to the overall LD sample. The second cluster included 7 students who displayed an overall deficiency, with severe problems in reading and spelling (below -2 SD). The third cluster contained 4 students, for whom all profiles points were above -1, with a relative weakness in reading. These three clusters were significantly differentiated ($F(6, 36)=15.61$, $p<.001$). The following univariate tests showed significant cluster effects for the two tests (reading, $F(2, 21)=26.9$, $p<.001$; spelling, $F(2,21)=75.35$, $p<.001$).

Insert Figure 5 about here

Figure 6 illustrates the 3-cluster solution in Grade 5. The fifth grade LD sample had the same pattern as those of the other grade levels: an overall deficiency. The first cluster consisted of 3 students who showed severe deficiency across all areas (below -2 SD). The second cluster (n=6) also displayed an overall deficiency similar to the first cluster but less severe.

The third cluster (n=7) displayed a specific deficiency in reading. There were also differences among these clusters in a MANOVA ($F(6, 22)=9.98$, $p<.001$). The following univariate tests were also significant: written expression ($p<.01$) and spelling ($p<.001$).

Insert Figure 6 about here

Figure 7 shows that the LD sample in Grade 6 seemed to have particular weaknesses in reading and spelling. Four clusters were identified at this grade level. The first two clusters both showed overall deficiency patterns, but were differentiated in terms of a degree of severity in deficiency of a particular area: The first cluster showed a severe deficiency in spelling (below -2 SD) and an overall deficiency in the rest of the areas. Like the second cluster in Grade 5, the next cluster appeared to be deficient across all academic areas. The third cluster, containing 4 students, can be interpreted as a reading-spelling deficit subtype. The fourth cluster, formed by 3 students, showed a deficiency in written expression. A MANOVA revealed differences among clusters, $F(9,24)=7.85$, $p<.001$, with all univariate tests (reading, written expression, and spelling) being significant ($p<.05$).

Insert Figure 7 about here

Discussion and Conclusions

As a validation of the BASS in identifying at-risk students, the questions proposed in this exploratory study were as follows: Were meaningful subtypes

identified at each grade level by application of cluster analysis using the BASS subtests? Would some of the subtypes be further differentiated as grade level increased?

The LD sample showed general deficiencies across three language-related academic skill areas at each grade level, compared to the grade norm. The number of interpretable clusters ranged from two to four, with the number increasing at higher grade levels. This indicates that more differentiated subtypes exist among older students. Generally, clusters were identified that represented both overall deficiency across areas and specific deficiencies in particular areas. The degree of differentiation of the patterns appeared to increase with age. That is, in the overall deficiency subtypes emerged - one representing moderate deficiency (below -1 SD) and the other severe deficiency (below -2 SD). In addition, subtypes representing both multiple-skill-deficiency and specific-skill-deficiency emerged in the intermediate grades.

The spelling subtest was an important factor in discriminating the clusters within the LD sample. Again, this measure showed substantial variability and turned out to be very sensitive to differences in grade levels (see Table 1 and Table 2). The reading subtest contributed less to the discrimination among the clusters, since reading was a common problem in almost all of the major clusters in grades two through six. In Grade 1 and Grade 4, there were some clusters that showed no deficiencies across the BASS subtests. The existence of this "non-deficiency" cluster could be due to several factors (Espin, Deno, Maruyama, & Cohen, 1989). First, it is conceivable that some students were not referred to special education on the basis of achievement in reading, but rather on the basis of other factors, such as behavioral problems. Second, especially in Grade 1, the restricted range of scores may cause inaccuracy in discrimination. Third, after successful interventions, these students might be about to overcome underachievement, especially in the

basic academic skill areas. It would be interesting to see if students from this "non-deficiency" cluster continued to stay in special education.

The present study employed subjects at the elementary level. Each grade-based sample in this cross-sectional study was analyzed separately. Therefore, caution must be exercised in making inferences about developmental trends. Although the analyses presented identified some common categories, it cannot be concluded with certainty that this phenomenon would always occur. The extent to which profiles do or do not vary as a consequence of developmental change cannot be evaluated fully in a cross-sectional study; data from a longitudinal study would be necessary in order to deal with this issue.

The validity of the subtypes would have been strengthened by the use of additional criterion measures. A future study should include an investigation of the relationship between subtypes and other criterion measures such as achievement tests or teacher observations. Another problem was that there were very small clusters, sometimes, with as few as 3 students in Grade 6, even though more than 2,500 students were involved in the original sample. A replication of these small clusters in a new dataset in needed. Lastly, the use of cluster analysis as a multivariate classification method has its own inherent limitations (Satz & Morris, 1981). Cluster analysis includes numerous methods, many of which have never been critically examined. Different classification problems require different methods, which can create problems not always apparent.

Although the subtypes identified in this study must be considered as preliminary due to the limitations specified above, the interpretation of the clusters and the trends were supported by the age-old hypotheses of stability and differentiation of ability and achievement. The utility of direct measurement of academic skills provided by measures such as the BASS should also be mentioned. This study showed that the BASS measures could

be used to identify students with learning problems and the subtypes of those problems in terms of specific skill deficiencies.

The BASS was developed as a screening measure for early identification of students in need of additional help; it can be easily administered by teachers in a short time period. The results from the BASS measures can be transferred to a baseline data for further continuous monitoring procedures such as CBM. The evidence strongly suggests that a viable assessment and treatment linkage may result by combining more direct, possibly repeated, measures of the academic skills actually taught in the classroom with direct remediation of identified academic problems (Ysseldyke & Mirkin, 1982).

Classification is a fundamental topic in all sciences. A classification system forms the basis upon which a theory can be developed. Cluster analysis is a quasi-statistical procedure used to create more homogeneous groups which may have important theoretical and practical implications for the field. As McKinney (1984) contended, one promising application of the results of this study is showing a way to lead better defined and more reliable sample selection procedures and ultimately produce a more generalizable body of knowledge in the field.

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Table 1

Participants by Grade and Gender (Frequency)

	Grade						
	1	2	3	4	5	6	Total
LD							
Male	7	17	20	21	10	9	84
Female	6	7	8	7	6	7	41
Total	13	24	28	28	16	16	125
Whole Sample							
Male	245	214	233	213	199	151	1255
Female	247	256	246	231	214	143	1338
Total	492	471	479	444	413	294	2593

Table 2

Means and Standard Deviation for BASS Reading, Written Expression, Spelling, and Math measure by Grade Level: Whole Sample

	Grade					
	1	2	3	4	5	6
Reading						
M	1.81	5.26	7.52	8.95	10.77	12.26
SD	1.52	2.82	3.15	3.11	3.56	3.65
Written Expression						
M	6.54	16.38	22.87	27.81	33.13	37.65
SD	4.12	7.12	8.26	8.93	9.21	8.29
Spelling						
M	36.54	63.20	74.03	80.35	85.20	86.92
SD	14.64	15.17	12.85	9.89	8.43	8.00

Table 3

Means and Standard Deviation for BASS Reading, Written Expression, Spelling, and Math measure by Grade Level: Learning Disabilities

	Grade					
	1	2	3	4	5	6
Reading						
M	1.10	2.61	3.49	4.77	6.02	7.81
SD	.77	1.74	2.18	1.74	2.46	2.11
Written Expression						
M	2.92	7.83	14.23	19.48	20.78	32.03
SD	2.05	3.69	6.60	6.75	9.40	7.33
Spelling						
M	20.96	44.13	53.93	64.91	69.59	75.22
SD	12.48	13.98	14.06	10.12	14.68	12.02

Figure Captions

Figure 1. An illustration of outliers

Figure 2. Comparison of BASS Clusters of Students with Learning Disabilities: Grade 1

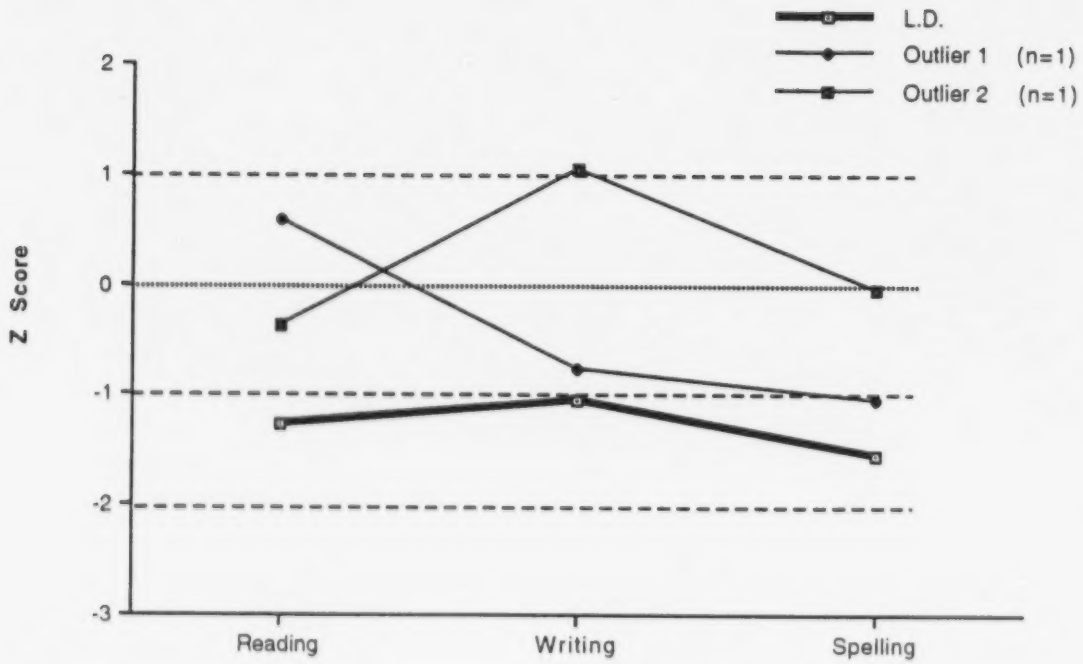
Figure 3. Comparison of BASS Clusters of Students with Learning Disabilities: Grade 2

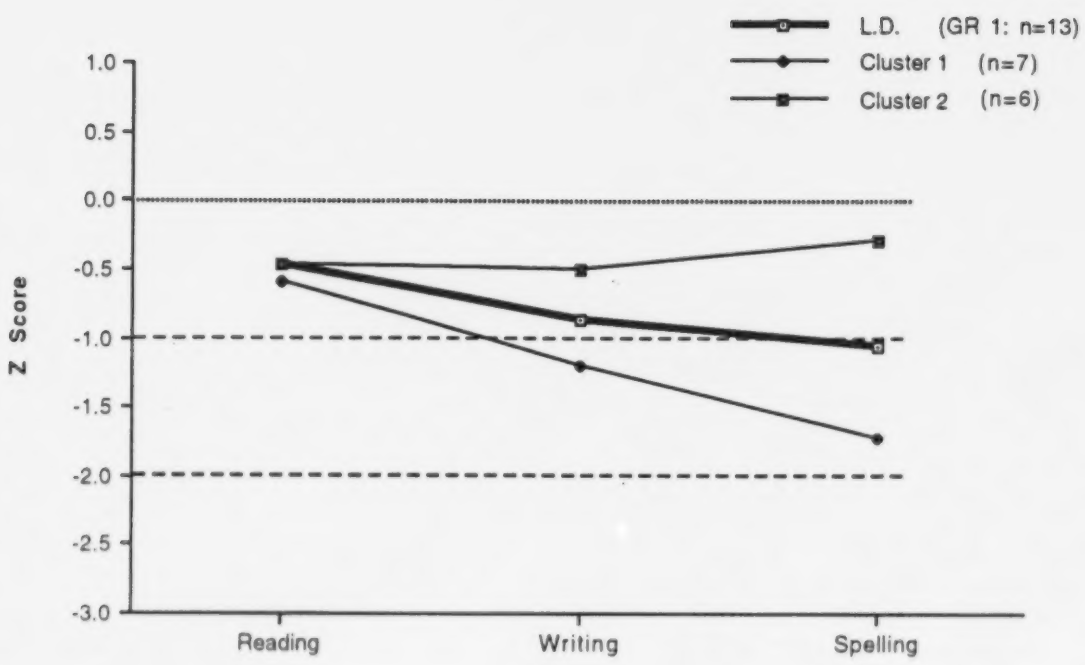
Figure 4. Comparison of BASS Clusters of Students with Learning Disabilities: Grade 3

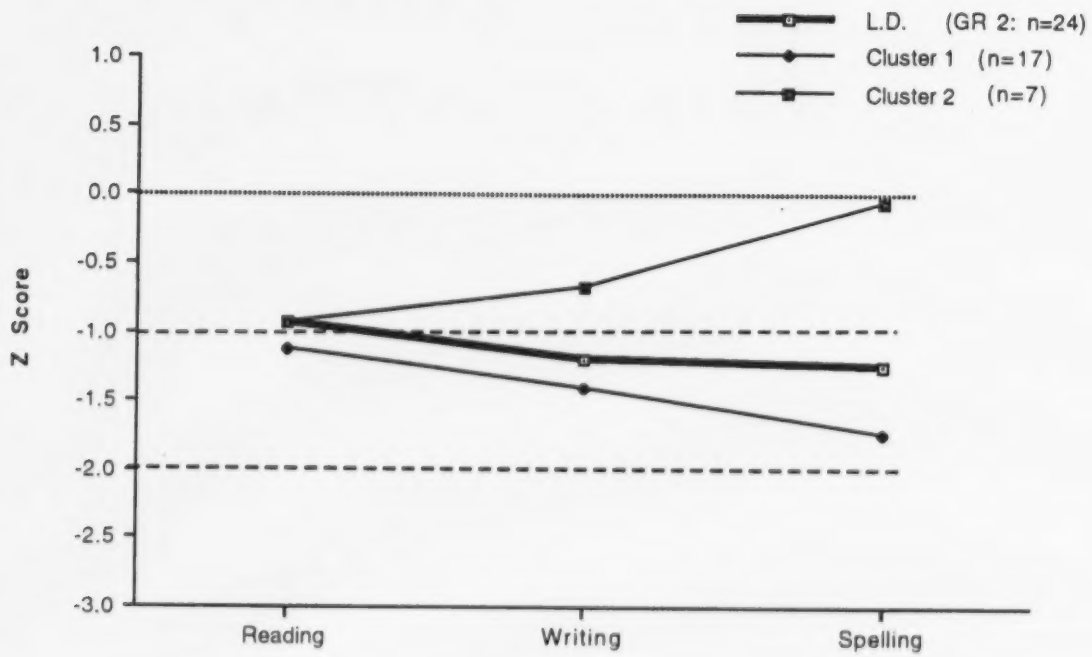
Figure 5. Comparison of BASS Clusters of Students with Learning Disabilities: Grade 4

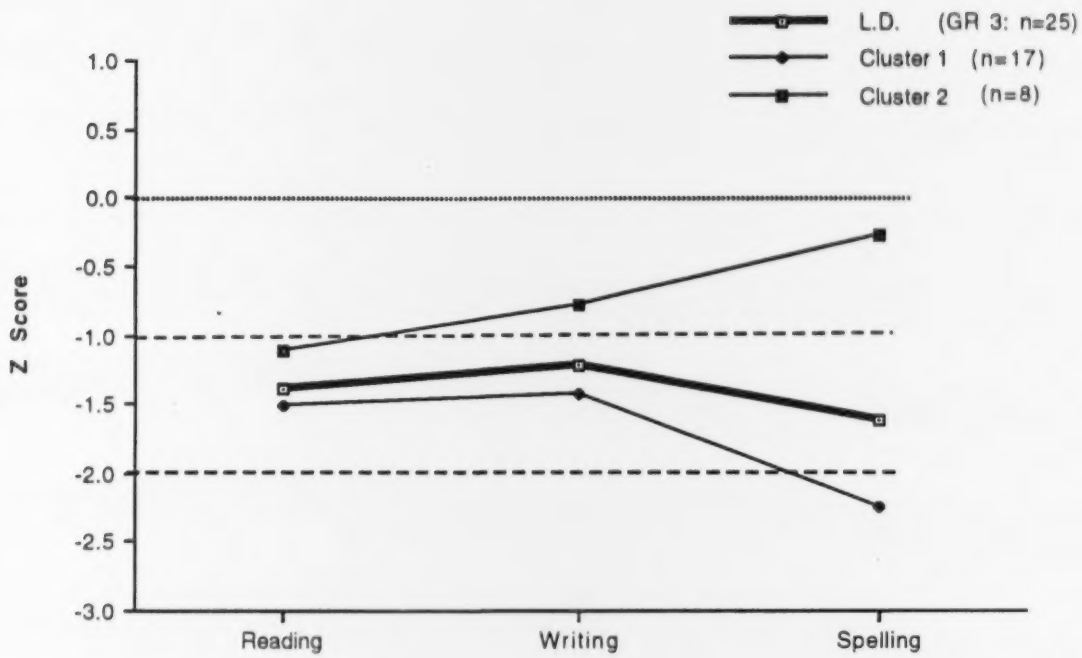
Figure 6. Comparison of BASS Clusters of Students with Learning Disabilities: Grade 5

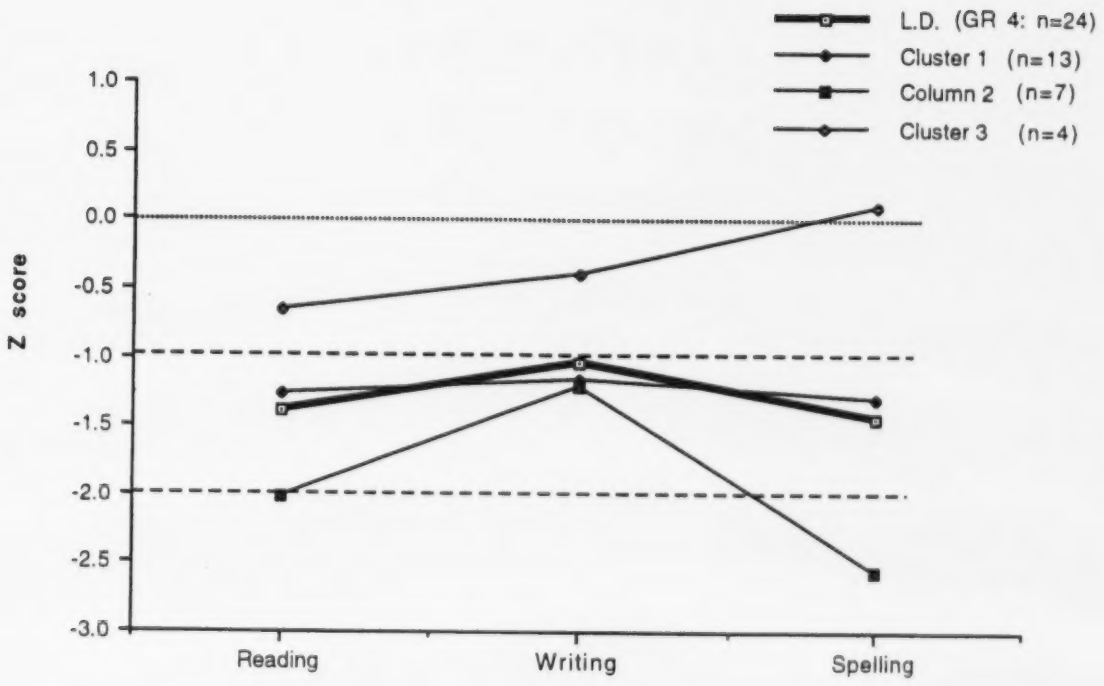
Figure 7. Comparison of BASS Clusters of Students with Learning Disabilities: Grade 6

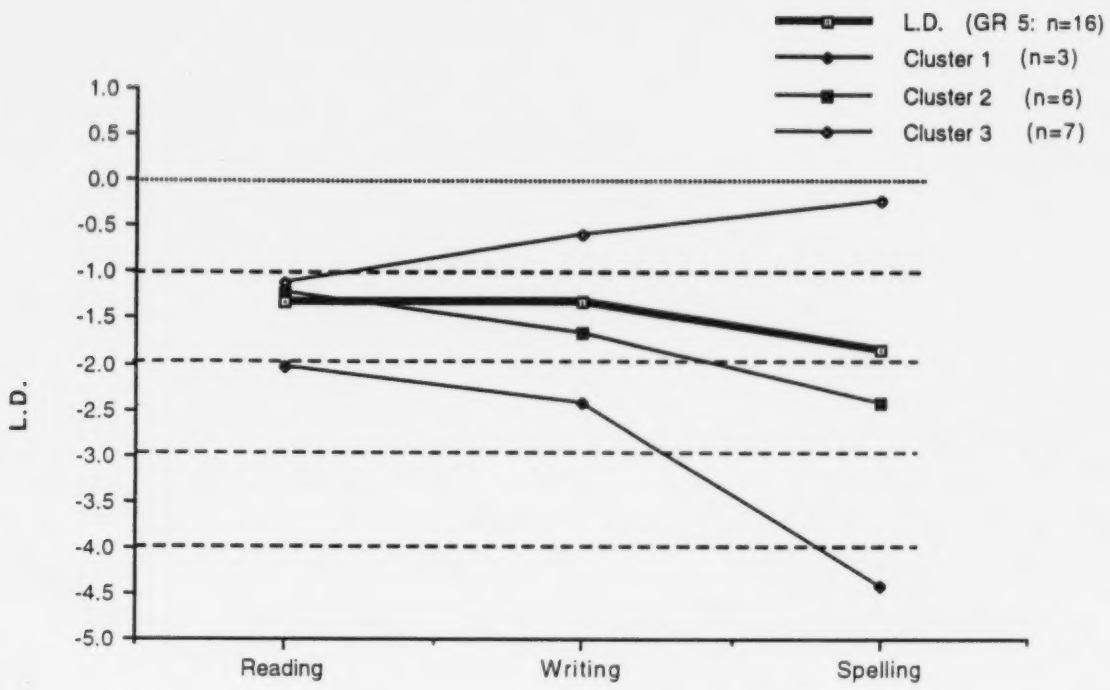

L.D.
Outlier 1 (n=1)
Outlier 2 (n=1)
Z Score
2
1
0
-1
-2
-3
Reading
Writing
Spelling

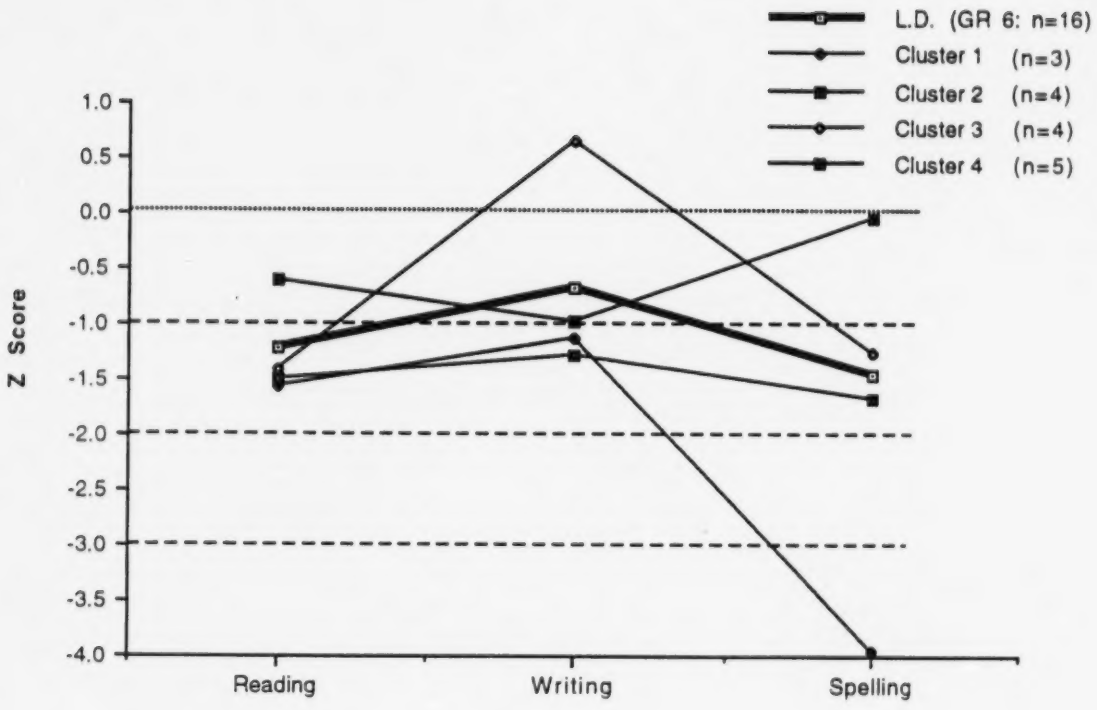

L.D. (GR 1: n=13)
Cluster 1 (n=7)
Cluster 2 (n=6)
1.0
0.5
0.0
-0.5
-1.0
-1.5
-2.0
-2.5
-3.0
Z Score
Reading
Writing
Spelling


L.D. (GR 2: n=24)
Cluster 1 (n=17)
Cluster 2 (n=7)
1.0
0.5
0.0
-0.5
-1.0
-1.5
-2.0
-2.5
-3.0
Z Score
Reading
Writing
Spelling


L.D. (GR 3: n=25)
Cluster 1 (n=17)
Cluster 2 (n=8)
1.0
0.5
0.0
-0.5
-1.0
-1.5
-2.0
-2.5
-3.0
Z Score
Reading
Writing
Spelling


L.D. (GR 4: n=24)
Cluster 1 (n=13)
Column 2 (n=7)
Cluster 3 (n=4)
1.0
0.5
0.0
-0.5
-1.0
-1.5
-2.0
-2.5
-3.0
Z score
Reading
Writing
Spelling


L.D. (GR 5: n=16)
Cluster 1 (n=3)
Cluster 2 (n=6)
Cluster 3 (n=7)
1.0
0.5
0.0
-0.5
-1.0
-1.5
-2.0
-2.5
-3.0
-3.5
-4.0
-4.5
-5.0
L.D.
Reading
Writing
Spelling


L.D. (GR 6: n=16)
Cluster 1 (n=3)
Cluster 2 (n=4)
Cluster 3 (n=4)
Cluster 4 (n=5)
Z Score
1.0
0.5
0.0
-0.5
-1.0
-1.5
-2.0
-2.5
-3.0
-3.5
-4.0
Reading
Writing
Spelling